A Combination of Apparatus by which ordinary Anthracite Coal-waste, from the Dirt-banks at the Mines, can be successfully and profitably burned in the Furnaces of Stationary and Locomotive Boilers.

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Prominent and peculiar features in the landscape of the Coal Mining Regions are the enormous heaps of black and apparently useless material collected near the outlet of each mine. The nature of this material can be best understood by a brief consideration of the source from which it comes.

The coal measures are made up of veins of coal of varying thicknesses and constitution. The coal of which they are composed, especially in the thicker veins, has mixed with it layers of slate, sometimes in mass, at other times finely laminated and disseminated throughout the seam.

As the coal is found in beds interstratified with rocky formation, it is subject to similar accidents as are the rocks themselves when disturbed by convulsions of nature; therefore when portions of a vein are crushed and rendered unfit for use as marketable fuel, it must, notwithstanding its unfitness, be removed from the mine to permit access to the more valuable coal.

Seams of considerable thickness are usually divided into separate beds of varying thickness, by deposits of slate, which impurity must be removed in the preparation of the coal for the market; and the same seam may furnish several qualities of coal.

The great heaps of material to which we have referred, are thus the results of the various operations of mining and preparation of the coal for market. They contain therefore, in addition to the earthy matter, slate and rock already mentioned, a large portion of the purest coal taken from the colliery, not only that which is crumbled into small fragments during the operation of mining, but also that, which having passed through the breaking rollers is crushed into particles of too small size to be merchantable, and is for that reason consigned to the dirt heap. The last named contribution to the heap constitutes from twelve to fifteen per cent. of all the good coal that is mined, and is the result of the wasteful method which is employed to reduce the large lumps to the uniform sizes required by the demands of the trade.

Some of these heaps are the accumulations of half a century, and have been exposed during their formation to the action of the weather and such atmospheric influences as have lessened their value for heating purposes by loss of carbon and saturation with moisture.

We have therefore, in dealing with these masses as fuel, to overcome the difficulties consequent upon their containing a very large amount of incombustible matter, all of the elements for the ready production of clinker and incapability for producing an active or vigorous fire in the ordinary furnace.

To consume this material with useful effect, it is necessary either to sub-

ject it to a process that shall form it into masses of moderate dimensions, so that when thrown into a furnace, interstices may be left to allow of access of air to the surface of the lumps, in the same manner as is the case with ordinary lump coal; or else special means must be provided to retain and consume it in the furnace; and peculiar appliances be made use of to insure the passage of air through the fire-bed and its proper contact with the fuel. In either case provision must be made as far as possible for the prevention of the formation of large masses of clinker and the disposal of the ash.

The first method referred to, that of forming the coal waste into lumps of proper dimensions, by the admixture of clay or bituminous matter, or other cohesive material, can only be profitably employed when the cost of the operation is less than that of mining and preparing coal at the colliery.

Heretofore the largest proportion of the coal mined was from above the water level, and the comparatively low rate at which such coal was mined prevented the successful application of any processes for agglomeration.

As the coal above the water level is being exhausted and deep mining has become necessary, the increased cost has directed attention to the utilization of the waste coal under consideration.

A large investment of capital in machinery may bring the cost of manipulation below that of mining; but it is not likely that the run of the waste coal heap can be utilized by any such process, as it contains so large a proportion of foreign and incombustible material.

It is obvious that if the coal in its minutely sub-divided state can be advantageously consumed by means of any process or device which shall be moderately simple in its construction and no more expensive of maintenance, than an ordinary boiler furnace, the problem of utilization of coal waste will have been solved, and a very considerable economy in cost of fuel attained.

With this object in view, a method of consuming the material in ques tion has been devised and may be described as follows:

Air is injected into a closed ash-pan by means of a steam jet passing through one or more tubes. These tubes should be cylindrical, when volume of air without much intensity is sufficient; but when greater intensity is desired, as in the furnace of a locomotive, they should each be formed of two frustrums of cones, united at their smaller diameters; the proportions of the larger and smaller diameters varying with the degree of intensity of blast required.

The mingled air and vapor pass through a perforated fire-bed into the fuel in the furnace, and are thus evenly distributed through the fire, the fuel being spread over the fire-bed to a depth of about three inches.

The fuel upon the grate is gently lifted by the blast from over the perforations, the finer particles floating upon the current until the carbon is consumed; a large proportion of the ash passing off in a finely divided state, with the draft out of the stack.

The decomposition of the vapor in passing through the fire, results in

the production of hydrogen and hydrocarbon gases, in addition to the carbonic oxide usually formed.

The blue flame of carbonic oxide is to a great extent replaced by that of the hydrocarbons and hydrogen. The combustion of this fuel resembling that of bituminous rather than anthracite coal; the flame extending occasionally to a distance of over twenty feet, instead of as many inches, as is the case in the combustion of carbonic oxide gas from ordinary anthracite coal burned in the usual manner.

The decomposition of the vapor causes a considerable reduction of temperature in the furnace. This cooling effect in the furnace does not, however, result in a loss of heat, as the re-combustion of the hydrogen derived from the decomposition of the vapor yields as much heat as was absorbed in its formation.

To insure the rapid and complete combustion of the fuel, and prevent the formation of solid masses of clinker, it should be repeatedly stirred upon the fire bed with a rabble-shaped tool. This stirring process is an important element in the successful use of the fuel under consideration, as it serves to relieve the fire from the finely divided ash, which is thus exposed to and carried by the draught over the bridge-wall or through the flues of the boiler into the stack.

The perforated fire-bed forms an essential feature of the device, inasmuch as the loss of fuel through the grate during the stirring process is thereby greatly diminished, the average loss being less than two per cent. of the coal put into the furnace, whilst the weight of the fuel used for steam generation and stationary and locomotive boilers, is but slightly in excess of that which would be required of standard marketable sizes of prepared coal when burned in the same furnace with the ordinary bar grate in the usual manner.

The perforations in the plate of the fire-bed, are made from three-eighths to three-fourths of an inch in diameter, and from two to three inches from centre to centre.

Wrought iron is preferred for making the perforated fire-beds, as that material admits of the use of a much thinner plate than cast iron, and consequently there is less liability to obstruction of the air passages.

The exhaust blast of the locomotive is altogether unsuited to the consumption of the fuel under consideration, as by reason of its impulsive and vigorous lifting action, it is impossible to maintain the fire in the comparatively quiescent condition requisite for favorable results with anthracite coal dirt.

The usual method of urging the fire by means of the exhaust steam has therefore been entirely dispensed with, and instead of discharging the exhaust steam directly into the atmosphere, its heat is absorbed as far as possible, by passing it through tubular feed water heaters before allowing it to escape.

By this means, feed water is introduced to the boiler at a temperature in excess of 212° F.

A locomotive engine, using coal dirt exclusively for fuel, has recently been engaged in hauling coal trains over the Philadelphia and Reading Railroad, generating steam freely without the use of any portion of the exhaust steam as a draught-promoting agent, the substitute being a continuous supply of air and vapor, introduced into a closed ash-pan as above described, aided by very small jets of live steam in the chimney for the purpose of facilitating the passage upwards of the products of combustion.

These results obtained from many boilers now using the apparatus described, show that the hitherto neglected and apparently valueless material, known as coal dirt, can be profitably used for generating steam, and that hereafter it must be regarded as a fuel of great value.

Stated Meeting, March 17, 1876.

Present 16 members.

Dr. Bridges in the Chair.

A letter acknowledging the receipt of Trans. V. and Proc. 94, was received from the Boston Society of Natural History.

Donations for the Library were received from the Bureau of Mines at Victoria, the Society of Physical Science at Bordeaux, the Revue Politique, Canadian Naturalist, Boston S. N. H., American Antiquarian Society, Bedford Library, Astor Library, Franklin Institute, Medical News, Prison Discipline Association, Geological Survey of Pennsylvania, Geological Survey of Ohio, and President Allen.

Prof. Houston communicated again his views respecting the so-called new force, and in reference to certain strictures which have appeared in print, since his former communication. He described the results of experiments proving a polar condition of the force, and demonstrating the impossibility of its being anything but electricity under stratical tension.

Mr. Eli K. Price continued the communication of his views on the Glacial Epoch, so-called, arguing against a general polar outspread of ice, and for the explanation of all drift phenomena on the theory of iceberg distribution.